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FOREST PEST MANAGEMENT
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AN EVALUATION OF THE GREAT BASIN TENT CATERPILLAR SITUATION, INYO NATIONAL FOREST

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ABSTRACT

A Great Basin tent caterpillar egg mass survey was conducted on the Mammoth, Mono Lake and White Mountain Ranger Districts during the week of September 12-16, 1983. Results indicate that 1984 populations will likely be at about the same or somewhat higher levels than in 1983. Past tent caterpillar outbreaks on antelope bitterbrush on the Inyo National Forest have generally lasted 2-4 years and it may be that such a cycle was detected in an early stage this year (1983) on the Hot Creek and Convict grazing allotments (Mammoth Ranger District) and in several areas on the White Mountain Ranger District. The total area involved is about 6000 acres. Current knowledge of Great Basin tent caterpillar population dynamics and damage potential to bitterbrush is summarized. The pest management alternatives of 1) continuing current management direction, 2) direct suppression and 3) information acquisition are discussed.

INTRODUCTION

The Great Basin tent caterpillar (GBTC), Malacosoma californicum fragile (Lepidoptera: Lasiocampidae) is a periodic defoliator of antelope bitterbrush, Purshia tridentata (Rosacae), an important browse species for wildlife and domestic livestock in east-central California. Defoliation attributable to the GBTC has been recorded intermittently in the Mono Lake - Mammoth Lakes area since 1937-38. The most recent outbreak occurred between 1973 and 1977 and caused defoliation to occur over a total of about 38,000 acres. Areas with tent caterpillar defoliation reported since 1973 are shown in Figures 1-3. In the spring and early summer of 1983, larvae, tents and defoliation were observed on the Hot

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Creek and Convict grazing allotments, Mammoth Ranger District. At the request of Brian Bell, Resources Officer, Mammoth Ranger District, these areas were briefly evaluated by Bruce Roettgering and John Wenz, Entomologists, Forest Pest Management Staff on June 21, 1983. A follow-up egg mass survey was conducted during the week of September 12-16, 1983, to provide an estimate of GBTC activity and damage in 1984. This report summarizes the results of that survey and presents potential management alternatives.

BIOLOGY

In the Mono-Mammoth Lakes area, bitterbrush is the preferred host plant for GBTC, but it is also reported to feed and oviposit on desert peach, Prunus andersonii (Rosacae). The GBTC has a one-year life cycle and adult flight and oviposition occurs June through mid-August. Each female generally produces one egg mass containing approximately 100-200 eggs; adults do not feed and live only a few days. Great Basin tent caterpillar egg masses are deposited on live twigs or branches and do not encircle the entire branch (clasping type egg mass). Each egg mass is covered with a brown or grayish frothy material called spumaline. The spumaline functions as an adhesive to hold the eggs in place, absorbes moisture from the air to help prevent the eggs from desiccating and may be of some protection from parasites. The winter is spent as diapausing first stage larvae within the eggs. The larvae hatch in the spring soon after the new bitterbrush leaves appear and the flower buds are formed which, in the Mono-Mammoth Lakes area, frequently occurs sometime in April.

There are usually five (sometimes six) larval instars (stages) and the larvae construct conspicious web-like tents that they enlarge as they mature. After hatching, the first stage larvae tend to crawl to the tips of the twigs where they feed on the new foliage and initiate tent construction. At low population densities the larvae from each egg mass build their own tent which can reach 5-6 inches in length by the time the larvae are in the 4th or 5th instar. At higher population levels, progeny from more than one egg mass often combine to construct a single tent which can be over a foot in length. It has been postulated that the tent functions as 1) a resting place between periods of feeding, 2) a moulting site and 3) a place of protection during periods of unfavorable microclimatic conditions. At the same time, the tents are conspicuous and may serve to both attract, and provide some protection from, natural enemies. In addition, it is likely that disease (nucleopolyhedrosis virus) transmission is enhanced by the increased contact between larvae and substrate resulting from repeated use of the same tent.

Larval development takes from 4-8 weeks. The early stages are quite gregarious, both feeding and utilizing the tents as a group. This habit decreases as the larvae mature and the last instar larvae tend to feed singly or in small groups. Just before pupation, some of the larvae may migrate randomly over both host and non-host plants. This local dispersal may occur more frequently at higher population densities and may be related to food availability. Pupation generally takes place from

late May through July in the Mono-Mammoth Lakes area. Coccons containing the pupae can be found in tents, rolled leaves, attached to twigs and branches and under debris at the ground surface. The pupal stage lasts about 2-2 1/2 weeks followed by emergence of the adults and egg mass deposition.

A number of natural enemies (insect parasites and insect and vertebrate predators) have been recorded from Malacosoma sp. Thirty-four insect parasites have been recoreded from GBTC on quaking aspen, but little is known about the tent caterpillar natural enemy complex on bitterbrush. Malacosoma sp. are susceptible to the bacterium, Bacillus thuringiensis and outbreakes of GBTC are frequently terminated by a naturally occurring nucleopolyhedrosis virus.

DAMAGE

The GBTC causes injury to bitterbrush by larvae feeding on the new foliage in the spring and early summer. Such defoliation can result in reduced twig growth and seed production as well as branch and plant mortality. The decreased seed production becomes evident the following year since flowers and seeds are not produced on the current years growth, but rather occur on spurs that develop from wood grown the previous year (flowering preceeds onset of twig growth in the spring). Most of the damage is caused by the last two larval instars which consume considerably more food than the earlier stages. While GBTC alone can cause mortality, the effects of a given level of defoliation on an individual bitterbrush plant can be influenced by plant conidtion, i.e., stressed plants are likely to be more severely affected than healthy individuals. Factors that can affect plant condition include grazing intensity, previous tent caterpillar defoliation, plant age and moisture stress, and should be considered in evaluating GBTC-related damage. At the same time, bitterbrush has the capability to refoliate and some individuals, completely defoliated by GBTC in the spring, have been observed to refoliate later in the season (September). It is conceivable that low levels of GBTC feeding on ungrazed or lightly grazed plants may stimulate regrowth and promote plant vigor.

The relationships between tent caterpillar population density, levels of defoliation and unacceptable damage levels are not known. Two references provide some insight into potential GBTC damage levels. First,[1/] in a 1943-44 GBTC outbreak in Modoc County, California, covering about 70,000 acres, it was estimated that the bitterbrush was completely defoliated over one-half the area and that grazing capacity was reduced by 25%. The affected range was used by both domestic and wild animals and reportedly much of the bitterbrush mortality had not been replaced

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1/ Clark, F.C. 1956. The Great Basin Tent Caterpillar in Relation to Bitterbrush in California. Calif. Fish and Game, Vol. 42 (2): 131-142.

by 1956. It is not clear to what extent, if any, overgrazing contributed to the mortality. In the second case,[2/] no appreciable mortality to greenleaf manzanita and mountain whitethorn ceanothus was observed during a 3-year outbreak in Lassen County, California. One year after the outbreak, most of the defoliated plants were starting to recover.

Some additional perspective on tent caterpillar related damage may be gained from a bitterbrush damage/condition survey[3/] conducted on the Mono Lake District in 1978, one year after GBTC populations had collapsed in most areas. In this survey, a series of 32 plots, 1/24 acre in area (6' x 300'), were established on the District. Ten of these plots were in areas heavily defoliated by the GBTC between 1973 and 1977 (heaviest defoliation occurred in 1976 and 1977), and 22 on rangeland areas with evidence of tent caterpillar activity (tents), but with less defoliation. The survey data indicated that about 5% of the bitterbrush plants (50 plants/acre) were completely defoliated and that 22% (222 plants/acre) were 50% or more defoliated (Table 1). The comparable figures were somewhat higher for the plots located in the more heavily defoliated areas. As noted above, some bitterbrush plants that are 100% defoliated have the capacity to refoliate later in the year and thus, the 5% of the total plants with 100% defoliation cannot necessarily be equated with mortality. It should also be noted that these damage figures may also reflect the influence of below normal precipitation in 1975-76. No follow-up study was conducted to obtain mortality/recovery estimates, but good current year leader growth was observed in all areas. The heavily defoliated plots had more plants per acre than the lightly defoliated areas.

No tent caterpillar population data was taken in conjunction with the 1978 survey and it is not possible to relate specific GBTC density levels to particular defoliation and mortality levels nor is there a record of how many years of defoliation each area received. Information on other factors affecting the survival and condition of bitterbrush was also not included. Taking this into consideration, the 1978 survey provides the best information currently available on tent caterpillar-related damage to bitterbrush.

2/ Wickman, B.E. 1962. Effects of Defoliation by the Great Basin Tent Caterpillar on Greenleaf Manzanita and Mountain Whitethorn Ceanothus. Pacif. Southwest For. and Rge Exp. Station, Res. Note No. 204, 3 pp.

3/ Manning, M. 1978. Review of the Great Basin Tent Caterpillar (Malacosoma fragile) on the Mono Lake District. 17 pp. (unpublished report).

EGG MASS SURVEY

Methods

Two methods were used to survey egg masses. First, twenty plots were surveyed in an effort to identify areas likely to have moderate to high populations in 1984 (Figures 1-2). Each plot consisted of 15 bitterbrush plants over a 1/4- to 1/2-acre area. The number of tents, 1982-83 (old) and 1983-84 (new) egg masses were recorded for each plant. Both the number of egg masses found and the ratio of new to old egg masses may give an indication of population trend from one year to the next.

In addition, point transects were established on the two grazing allotments identified in the initial detection report (Fig. 2). The transect lines were run at 1/4-mile intervals perpendicular to, and on alternating sides of, a road running through the areas. Each transect consisted of five sample points one chain apart. At each point, two branches were selected from the opposite sides of each of two plants. The branches were examined for tents, and old and new egg masses. The percent defoliation and evidence of refoliation were also recorded. Thus, each transect was comprised of a total of 10 plants and 20 branches. In addition, each sample plant was briefly checked for tents and other old or new egg masses on branches other than the two sample branches. Five transects were run on the Hot Creek allotment and four on the Convict allotment.

Results

Tents and egg masses were found on 13 (65%) of the 20 survey plots (Table 2). Of the plants on these 13 plots, about 33% (64/195) had at least one tent and one new egg mass (no egg masses were found on plants without tents). By way of comparison, data from the 1978 Damage Survey referenced above, indicated that 94% of the total bitterbrush plants surveyed were fed on by GBTC during the outbreak. Four of the 13 plots (No.'s 3, 12, 14 and 19) had a new-to-old egg mass ratio of at least 1.3:1 and an additional six plots had at least a 1:1 ratio. The ratio's ranged from 0.3 to 1.8:1. Plots with the highest number of tents tended to have the most new egg masses and the highest new-to-old egg mass ratio. The 64 plants with tents averaged about 1.6 tents and almost 2.0 new egg masses per plant. New egg masses, by plot, ranged from 0 to 41 and approximately 33% of all new egg masses were found on one plot (No. 12, Hot Springs allotment). Averages for all 195 plants on the 13 plots with at least one tent and egg mass were 0.5 tents and 0.6 new egg masses per plant or 7.7 tents and 9.6 new egg masses per plot. On a total plot (20) basis, the averages were 5.0 tents and 6.3 new egg masses per plot.

Results from the transects on the Hot Creek (A) and Convict (B) grazing allotments (Fig. 2) are given in Table 3. The new-to-old egg mass ratios from both allotments are consistent with those from the corresponding survey plot (No.'s 12 and 14 respectively) estimates. In the Hot Creek allotment, 30% of the plants sampled had tents and egg masses while in the Convict allotment, 18% of the plants had tents and egg masses. Virtually all old egg masses found in both the transects and

plots had one tent closely associated with it, frequently located distal to it on the same branch. No tents and only about 20% of the total new egg masses encountered on the transects were found on the actual sample branches.

Observations from all sample areas indicate that at the population and damage levels encountered, most new egg masses are deposited in the vicinity of, but not necessarily on, the same branches as the previous years tents and egg masses. A number of cocoons were found in the old tents; a few were observed in partially rolled-up leaves. In conjunction with the fact that no egg masses were found on plants without tents, it appears that little late - instar larval migration occurred and that the adult females did not disperse widely before ovipositing. In addition, the bitterbrush in all areas sampled looked healthy with good growth and refoliation; little evidence of damage in the form of twig and branch dieback was observed.

DISCUSSION

Great Basin tent caterpillar populations exhibit considerable year-to-year variataion. A few tents can be found almost every year, but outbreaks occur relatively infrequently. Sound methods to predict GBTC population trends are not currently available, but based on the results of the egg mass survey, it appears likely that 1984 tent caterpillar populations and defoliation will be at about the same or somewhat higher levels than in 1983 unless significant overwintering or early spring mortality occurs. Great Basin tent caterpillar outbreaks in the area have generally lasted 2-4 years and it may be that such a cycle was detected in an early stage this year in the Hot Creek and Convict allotments. In addition, GBTC tents have been reported in several areas on the White Mountain Ranger District in both 1982 and 1983 (Fig. 3). The between-site variation evidenced in the egg mass survey indicates that if increases in population levels and defoliation occur, it will be in relatively discrete areas rather than over large, contiguous rangeland areas. In the 1973-77 outbreak, there were approximately 10 such areas on the Mono Lake and Mammoth Districts, ranging in size from about 500 to 7,000 acres (Figs. 1-2). A similar pattern may emerge over the next few years if populations do not decline due to natural factors.

The main short-term management concern is whether tent caterpillar defoliation can temporarily reduce bitterbrush browse and/or seed production to the extent that utilization of the affected range areas should be reduced or eliminated for some period of time. It has been estimated[4/] that a) approximately 40% or more of the current-years' twig growth should remain on the plant to maintain vigor and provide for adequate seed production and b) removal of 50% or more of the foliage

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4/ Hormay, A.L., 1943. Bitterbrush in California. Calif. For. and Range Exp. Sta., Res. Note No. 34, 13 pp.

through defoliation can reduce or prevent flower production the following year. The 1978 damage survey may provide an indication or broad estimate of damage levels that can reasonably be expected from a 4-year GBTC outbreak (i.e., approximately 20-25% of the plants defoliated 50% or more, which may or may not include some level of grazing in addition to tent caterpillar caused defoliation). If such levels of damage are determined to have sufficient short-term negative impacts on browse production, a potential consequence could be a temporary reduction in, or elimination of, use of the affected areas, with subsequent local economic/social impacts.

The long-term effects of tent caterpillar defoliation, interacting with other factors, on sustained range productivity and condition are not known. Both the GBTC and antelope bitterbrush are native species and have evolved in this area (prior to the introduction of domestic livestock) along with other less palatable rangeland species like big sagebrush, Artemisia tridentata, and rabbitbrush, Chrysothamnus sp. It is unlikely that the GBTC, by itself, will cause widespread mortality to its primary host plant. However, in combination with other factors, it is conceivable that the GBTC could contribute to decline of bitterbrush in localized areas through mortality and competitve displacement. Information from range Trend and Condition Surveys conducted on the Forest/District may provide some indication of general bitterbrush status.

MANAGEMENT ALTERNATIVES

1. Continue Current Management Direction. Under this alternative, population and damage monitoring in cooperation with the FPM Staff would continue at current levels in 1984. The consequences of this alternative, in terms of tent caterpillar population changes and subsequent short and long-term damage to bitterbrush are as discussed in the previous section.

2. Suppression. Several chemicals including carbaryl, diazinon and malathion as well as the bacterium, Bacillus thuringiensis, are available for use against GBTC larvae on bitterbrush. Proper use of any of these materials can reasonably be expected to result in 80% or more larval mortality with some corresponding reduced level of defoliation. Immediate suppression costs would probably be between $5-$15/acre. The main considerations in evaluating this alternative are whether (a) without suppression, unacceptable levels of damage will occur and (b) that the treatment will reduce damage to acceptable levels in an economically efficient and environmentally acceptable way. Current uncertainties in predicting GBTC population levels and associated damage/impact, make it difficult to resolve these considerations with a reasonable degree of reliability.

3. Obtain Needed Information. Under this alternative, a joint FPM-Forest/District evaluation would be initiated on GBTC-bitterbrush dynamics to provide information needed to make more informed GBTC-bitterbrush management decisions.

At a minimum, such an evaluation conducted over 2-5 years, could determine the effect of defoliation caused by different GBTC larval population densities on bitterbrush growth (browse production) and survival. Although the emphasis would be on GBTC-bitterbrush interactions, other factors affecting tent caterpillar bitterbrush dynamics should be considered as appropriate. The direct costs of this alternative include time, personnel and dollars which will vary with the scope and duration (a wide range of possibilities exist) of the evaluation. A cooperative evaluation could be conducted that should yield useful damage/impact information with a moderate amount of effort. Obviously, if such information is not obtained via a formal evaluation, GBTC-bitterbrush management decisions will continue to be based on information levels as currently exist, but improved through time by unstructured qualitative observations. Given the potential, for the GBTC, interacting with other factors, to have long-term negative effects on bitterbrush, one consideration is, that if such adverse effects are in fact occurring, they may not become readily apparent until late in the process when it could be much more difficult and costly to deal with the situation.

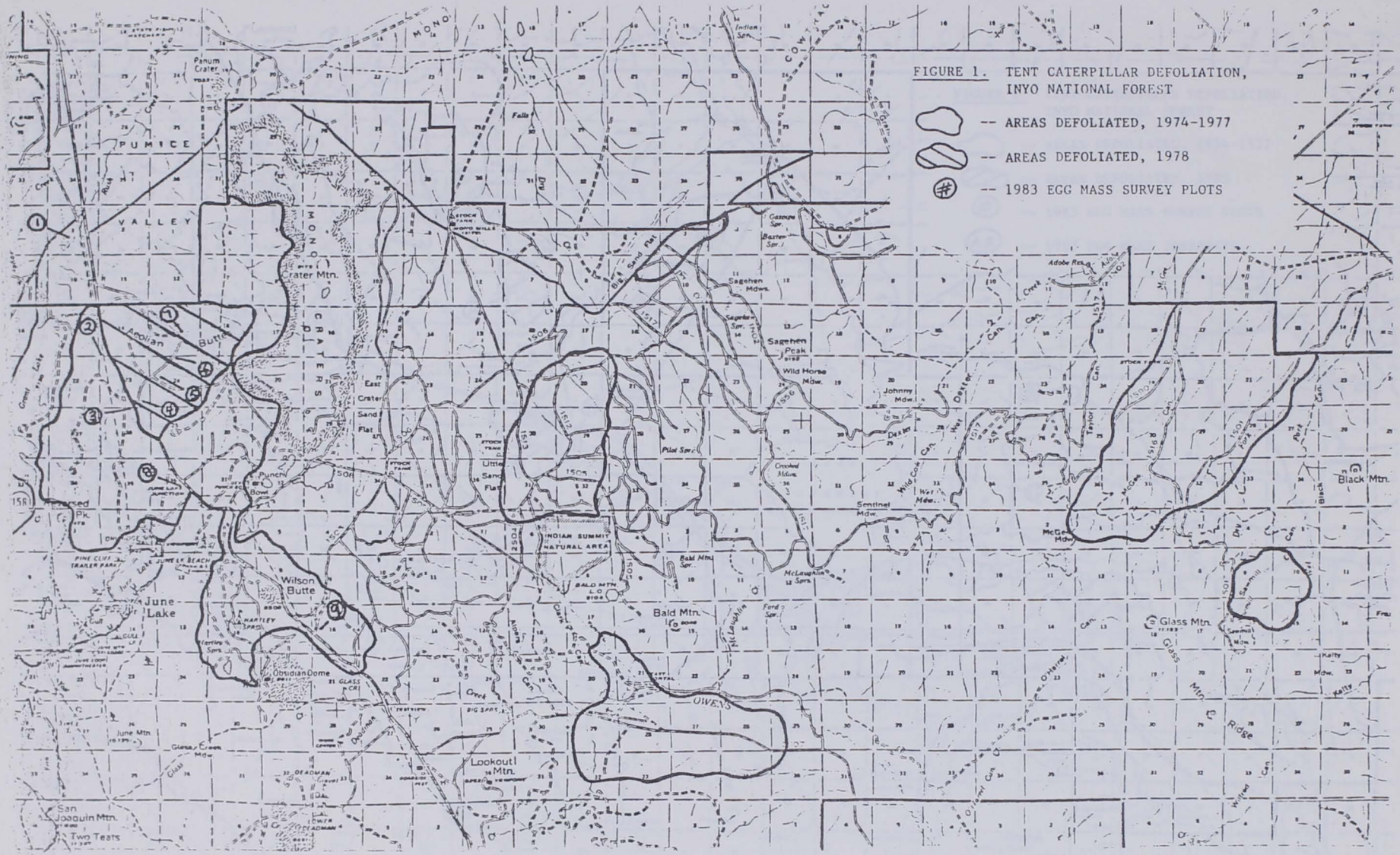
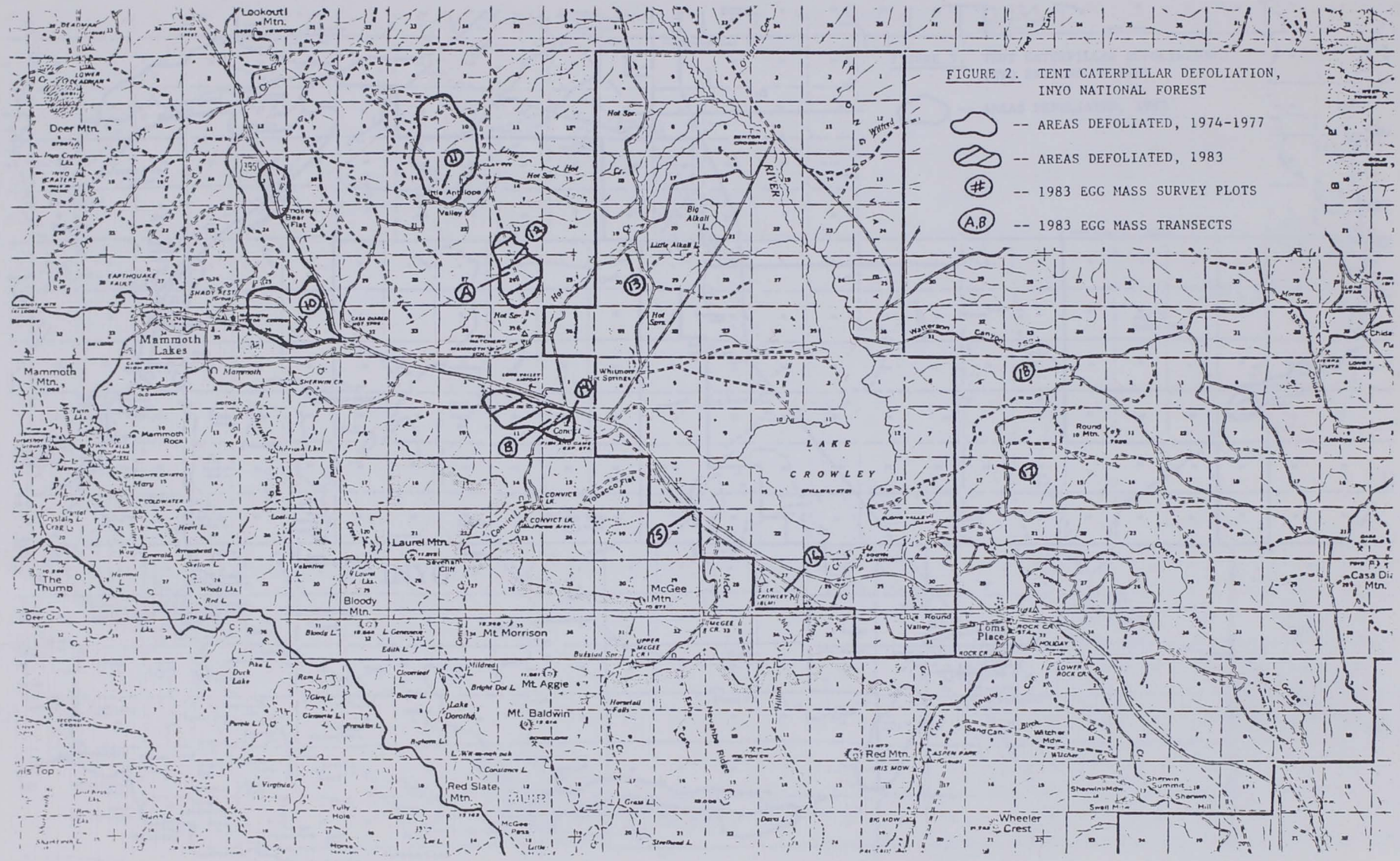


FIGURE 1. TENT CATERPILLAR DEFOLIATION, INYO NATIONAL FOREST

-- AREAS DEFOLIATED, 1974-1977

-- AREAS DEFOLIATED, 1978

(#) -- 1983 EGG MASS SURVEY PLOTS


Lookout Mtn.
Deer Mtn.
Mammoth Lakes
Mammoth Mtn.
Laurel Mtn.
The Thumb
Bloody Mtn.
Mt. Morrison
Mt. Aggie
Mt. Baldwin
Red Slate Mtn.
McGee Mtn.
Red Mtn.
Wheeler Crest
Casa Diablo Mtn.
Round Is Mtn.
Whitmore Springs
Hot Springs
Big Alkali L.
Little Alkali L.
Owens River
LAKE CROWLEY
Tobacco Flat
Convict L.
Little Antelope Valley
Smokey Bear Flat
Earthquake Fault
Shady Rest
Mammoth Rock
Crystal L.
Crab L.
Twin Lakes
Lake Mary
Lake Dorothy
Duck Lake
Red Top Mtn.
Sherwin Summit
Sherwin Hill
Sherwin Mdw.
Swall Mdw.
Watterson Canyon
Antelope Spr.
Hilton Creek
Owens River
Rock Creek
Lower Rock Creek
Pine Grove
Holiday
Birch Creek
Watcher Mdw.
Iris Mdw.
Aspen Flat
Sand Can.
Big Meadow
Lake Virginia
Tully Hole
Grass L.
Dorothy L.
Mildred L.
Bright Dot L.
Hemlock Falls
Newcomb Ridge
Hilton Ridge
Upper McGee Creek
McGee Pass
Little Round Valley
Owens Gorge
Hot Creek
Mammoth
Sherwin Cr.
Convict Lk.
Convict Cr.
Laurel Cr.
Deer Cr.
Mono Cr.
Rock Cr.
Big Meadow
Iris Meadow
Aspen Flat
Sand Can.
Watcher Mdw.
Birch Creek
Sherwin Mdw.
Swall Mdw.
Sherwin Summit
Sherwin Hill
Wheeler Crest
Casa Diablo Mtn.
Round Is Mtn.
Antelope Spr.
Watterson Canyon

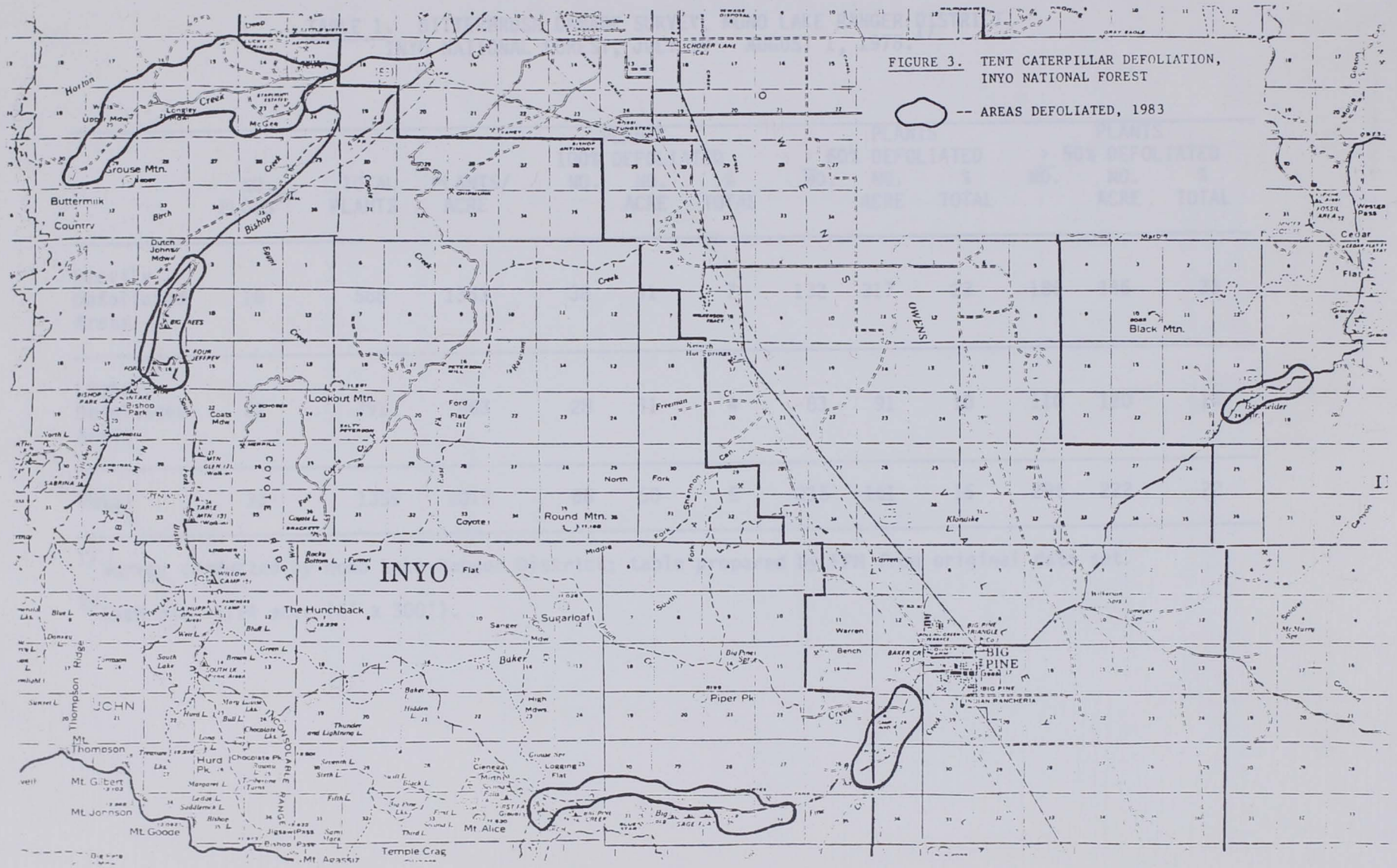


FIGURE 3. TENT CATERPILLAR DEFOLIATION, INYO NATIONAL FOREST

-- AREAS DEFOLIATED, 1983

TABLE 1. BITTERBRUSH DAMAGE SURVEY, MONO LAKE RANGER DISTRICT, INYO NATIONAL FOREST, JULY 19 - AUGUST 1, 1978.[1/]

	NO. PLOTS[2/]	TOTAL PLANTS	PLANTS/ ACRE	PLANTS 100% DEFOLIATED NO.	NO. ACRE	% TOTAL	PLANTS > 60% DEFOLIATED NO.	NO. ACRE	% TOTAL	PLANTS > 50% DEFOLIATED NO.	NO. ACRE	% TOTAL
Heavily Defoliated Areas	10	568	1363	38	91	7	132	317	23	186	446	33
Lightly Defoliated Areas	22	791	863	28	31	4	83	91	10	110	120	14
Total	32	1359	1019	66	50	5	215	161	16	296	222	22

[1/] Survey conducted by Mono Lake Ranger District; table prepared by FPM from original data set.

[2/] Each plot 1/24 acre (6' x 300').

TABLE 2. GREAT BASIN TENT CATERPILLAR EGG MASS COUNTS, MAMMOTH, MONO LAKE AND WHITE MOUNTAIN RANGER DISTRICTS, INYO NATIONAL FOREST, SEPTEMBER 14-16, 1983

PLOT[1/]	NO. PLANTS WITH TENTS	TOTAL NO. TENTS	NO. EGG MASSES 1983-84 NEW	NO. EGG MASSES 1982-83 OLD	NEW : OLD EGG MASS RATIO
1	0	0	0	0	
2	4	6	7	6	1.2:1
3	7	9	16	9	1.8:1
4	0	0	0	0	
5	3	3	3	3	1.0:1
6	0	0	0	0	
7	5	6	5	6	0.8:1
8	3	3	3	3	1.0:1
9	0	0	0	0	
10	8	11	12	11	1.1:1
11	1	2	2	2	1.0:1
12	11	29	41	29	1.4:1
13	0	0	0	0	
14	8	14	21	14	1.5:1
15	2	3	1	2	0.5:1
16	4	4	1	4	0.3:1
17	0	0	0	0	
18[2/]	0	0	0	0	
19[3/]	7	9	12	9	1.3:1
20	1	1	1	1	1.0:1
Total	64	100	125	99	1.3:1

[1/] There are 15 plants per plot (Total = 300 plants).

[2/] Plot located approximated one mile north of Conway Summit on the east side of Highway 395.

[3/] Plot located on the east side of Highway 395 on the Toiyabe National Forest, approximately two miles south of junction with Highway 108.

TABLE 3. GREAT BASIN TENT CATERPILLAR EGG MASS TRANSECT RESULTS, HOT CREEK AND CONVICT GRAZING ALLOTMENTS, MAMMOTH RANGER DISTRICT, INYO NATIONAL FOREST, SEPTEMBER 13, 1983.

TRANSECT	NO. PLANTS WITH TENTS[1/]	TOTAL NO. TENTS	NO. EGG MASSES ON SAMPLE BRANCHES 1983-84 NEW	1982-83 OLD	TOTAL EGG MASSES 1983-84 NEW	1982-83 OLD	NEW : OLD EGG MASS RATIO
Hot Creek (A)							
1	2	5	6	1	12	3	4.0:1
2	4	6	2	0	3	6	0.5:1
3	2	4	3	0	8	4	2.0:1
4	4	4	0	0	1	3	0.3:1
5	3	4	3	0	5	4	1.3:1
Sub-Total	15	23	14	1	29	20	1.5:1
Convict (B)							
6	1	1	1	0	4	1	4.0:1
7	1	1	1	0	2	1	2.0:1
8	4	11	0	0	13	11	1.2:1
9	1	1	0	0	1	1	1.0:1
Sub-Total	7	14	2	0	20	14	1.4:1
Total	22	37	16	1	49	34	1.4:1

[1/] There is a total of 10 plants per transect.

THE FOREST SERVICE OF THE U.S. DEPARTMENT OF AGRICULTURE is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through management of the National Forests and National Grasslands, cooperation with the States and private forest owners, and forestry research, it strives—as directed by Congress—to provide increasingly greater service to a growing Nation.

THE GOAL OF FOREST PEST MANAGEMENT is to reduce pest-caused damage and losses on all forests and rangelands to levels commensurate with management objectives. The Forest Pest Management Staff provides leadership to forest land owners in dealing with pest problems effectively, while minimizing adverse effects on man and his environment.